Requirements for Interim Certification of Filtration Devices for Total Suspended Solids Based on Laboratory Analysis
DRAFT April 28, 2009

The New Jersey Stormwater Management Rules at N.J.A.C. 7:8-5.5 require "major development" projects to remove 80% of the total suspended solids (TSS) in the projects' runoff. To help achieve this requirement, Table 2 at N.J.A.C. 7:8-5.5(c) provides a list of approved TSS removal rates for constructed stormwater best management practices (BMPs). However, the Rules specify at N.J.A.C. 7:8-5.7(d) that approved TSS removal rates for manufactured treatment devices (MTDs) must be verified by the New Jersey Corporation for Advanced Technology (NJCAT) and then certified by the New Jersey Department of Environmental Protection (NJDEP).

Final certification of such MTDs is to be based upon the results of field testing performed in accordance with the Technology Acceptance Reciprocity Partnership (TARP) Protocol for Stormwater Best Management Practice Demonstrations and any associated NJDEP amendments.

However, prior to the completion of field testing, manufacturers may be eligible for interim certification of their device's TSS removal rate from the NJDEP. For MTDs that rely upon filtration and sedimentation to remove TSS, an interim certification shall be based upon the results of a series of laboratory tests of the device performed in accordance with the following requirements.

In reviewing the requirements, it is important to note that the New Jersey Stormwater Management Rules at N.J.A.C. 7:8-5 specifically require the removal of TSS from stormwater runoff. This requirement was mandated through NJPDES Municipal Stormwater Phase rules in compliance with the requirements by the USEPA Stormwater Phase II Final Rule. In addition, the removal rates for constructed BMPs contained in Table 2 at N.J.A.C. 7:8-5.5(c) are specifically for TSS. Therefore, in compliance with the requirements of the New Jersey Rules and for consistency with the removal rates for constructed BMPs published in the New Jersey Rules as well as the New Jersey Stormwater Best Management Practices Manual, the interim certification requirements for Hydrodynamic Sedimentation Devices presented below specifically require the measurement of TSS during laboratory testing.

A. Manufactured Treatment Device Characteristics

Maximum Conveyance Flow Rate

The maximum conveyance flow rate (MCFR) of a filter device is the highest flow that can pass through the device without bypassing the filter.

Maximum Treatment Flow Rate

The maximum treatment flow rate (MTFR) of a MTD is the highest flow rate that ensures the performance and maintenance interval claimed by the manufacturer. Once it is determined and approved, a device's MTFR is used to select the appropriate size or model that will be capable of filtering the peak runoff rate to the device from the New Jersey Water Quality Design Storm as defined in N.J.A.C. 7:8-5.5. The MTFR shall be equal to or less than the MCFR.

Due to differences in devices, such as in cases where there is no internal bypass or overflow, the water level and/or other flow characteristics within the device to be used to determine its

MCFR and MTFR must be approved by the verification entity prior to conducting any interim certification lab testing. Once such levels and/or characteristics are approved, the MCFR and MTFR for a device shall be determined in the laboratory by measuring the flow rate that is conveyed through the device at these approved MCFR and MTFR characteristics. The final MCFR and MTFR determined in this manner shall be the arithmetic average of three laboratory flow tests using clear water.

Upon completion of these flow tests, both the MCFR and MTFR and their associated characteristics for the tested device shall then be utilized to derive a flow equation that can be used to develop the MCFR and MTFR for various filter conditions, including loss of flow capacity due to filter clogging. The flow equations shall also be used to determine the MCFR and MTFR of untested larger and smaller devices. These flow equations shall be based upon pertinent device dimensions, water levels, ratio of filter area to inflow, media dimensions, and an appropriate equation or equations for orifice, weir, pipe, and/or open channel flow.

Maximum Sediment Storage Depth and Volume

The maximum sediment storage depth and volume are used as indicators of required maintenance frequency. Due to differences in MTDs, the maximum storage depth and volume and their characteristics must be approved by the verification entity prior to conducting lab testing.

Effective Filter Area

The effective filter area is the area where treatment of the device occurs, and is typically the surface area of the filter in a filtration device. The effective treatment area is necessary to scale different size devices based on the device tested in the lab and the maximum treatment rate of the untested device. Due to differences in devices, the effective treatment area and its characteristics must be approved by the verification entity prior to conducting lab testing.

Effective Settling Area

The effective settling area is the area where settling of particulates occurs in the device, and is typically the water surface area of the chamber up-treatment of the filter media. Typically the filter media is physically located within this chamber. The effective settling area is necessary to scale different size devices based on the device tested in the lab and the maximum treatment rate of the untested device. Due to differences in devices, the effective settling area and its characteristics must be approved by the verification entity prior to conducting lab testing.

B. Laboratory Testing Criteria

Laboratory Qualifications

The analysis of stormwater shall be conducted by an independent laboratory, or shall be overseen by an independent party if conducted at the manufacturer's own laboratory. This analysis shall have either New Jersey Environmental Laboratory Certification using the standards published at N.J.A.C. 7:18, "Regulations Governing the Certification of Laboratories and Environmental Measurements" or New Jersey National Environmental Laboratory Accreditation using the 2003 NELAC Standard and incorporated by reference at N.J.A.C. 7:18-1.5(d).

If the manufacturer is using its own lab and an independent observer, the observer shall meet the following requirements:

i. The observer shall have no financial or personal conflict of interest regarding the test results.
ii. The observer shall have experience in a hydraulics, sampling and sedimentation lab, be familiar with the test and lab methods specified in this standard and have a professional license in an appropriate discipline.
iii. The observer shall approve the experimental set-up and lab testing protocol and observe the test during its full duration.

Temperature

The temperature of the water for all MCFR and MTFR test runs and TSS sample testing shall be between 73 and 79 degrees Fahrenheit.

Background TSS levels

Background levels of TSS shall be no more than 5 mg/l in all tests. The use of flocculants is not an acceptable means to reduce the background TSS levels. Any background level with a higher concentration must receive approval from the verification entity regarding whether the background concentration is acceptable and how adjustments should be made to address such concentrations in the analysis. If prior approval is not previously obtained from the verification entity, the testing performed by the vendor may not be accepted.

Full Scale

A full scale, commercially available device must be tested in the same configuration as proposed in actual installations, including but not limited to, sediment storage to inflow ratios, attenuation time, outlet depths, and energy dissipation as well as any other components that impact the TSS removal rate of the device.

C. Annual Total Suspended Solids (TSS) Removal Rate

Removal Efficiency Test Runs

A minimum of three test runs at constant flow rates of 25%, 50%, 75%, 100%, and 125% of MTFR at TSS concentrations of 50 and 100 mg/l shall be conducted using the NJPSD as shown in Table 1 below, resulting in a minimum of 30 total test runs, with an allowable variation in individual flow rates and in individual particulate concentrations of +10%. Devices that only allow flow at 100% of the MTFR may utilize the values obtained at 100% flow for 25%, 50%, and 75%. The test shall ensure that a 125% flow rate is either tested or that the removal rate is assumed to be 0 at the 125% flow.

Table 1: New Jersey Particle Size Distribution*

Particle Size (microns)	Percent by Mass
500 – 1000	5%
250 – 500	5%
100 – 250	30%
50 – 100	15%
8-50	25%
2 – 8	15%
1 – 2	5%

*The material shall be hard, firm, and inorganic with a specific gravity of 2.65(+5%).
*The various particle sizes shall be uniformly distributed throughout the preloaded material.
*The composite material shall have a median particle size of 67 microns ±10%.
*A variation of ±10% in each individual percentage is permissible provided that the individual percentage of the particles from 1 to 50 microns are not decreased and the net variation over all ranges shown in Table 1 above is 0%.

Maintenance Interval and Maximum Inflow Drainage Area Test Runs

To determine the device's required maintenance interval and maximum inflow drainage area (see below) the device shall be subject to a series of simulated storm events. Each simulated event shall last 60 minutes at a constant flow rate equal to the device's MTFR. The flow shall contain the NJPSD shown in Table 1 at a concentration of 200 mg/l ±10%. A 20 minute draindown time with no inflow shall be performed between each 60 minute simulated flow event. This series of 60-minute flow periods and 20-minute draindown periods shall continue until the device's MTFR is reduced during a flow event by 10%. As described below, the mass of NJPSD material necessary to create this 10% reduction in the device's MTFR shall then be utilized to determine the device's maintenance interval and maximum allowable inflow drainage area.

TSS Removal Rate

During each of the test runs described above, samples of the influent to and effluent from the device shall be taken and analyzed for TSS in accordance with Standard Method APHA 2540D. All sample data and analytic results must be provided as part of the submittal for interim certification. In addition, a particle size distribution of each TSS sample must also be determined and included in the submittal.

The TSS test results described above shall then be utilized to obtain average influent and effluent TSS concentration for each combination of flow rate and particulate concentration. Each average influent and effluent TSS concentrations shall then be multiplied by the associated flow rate to obtain average influent and effluent TSS load rates for each combination of flow rate and particulate concentration.

In addition to TSS, influent and effluent samples may also be collected and analyzed for Suspended Solids Concentration (SSC) in accordance with ASTM Method D3977-97. Such data may then be utilized to obtain average influent and effluent SSC concentrations and load rates in the same manner described above for TSS. If developed, such sample data, analytic results, and computations should also be provided as part of the submittal for interim certification. This information will provide a more robust database comparing TSS and SSC removal rates that may inform future changes by the NJDEP to these lab testing requirements.

The resulting average removal efficiency for each combination of flow rate and particulate concentration shall then be determined through the following equations:

$$\textbf{Average TSS Removal Efficiency} = \frac{(\text{Average TSS Influent Load Rate} - \text{Average TSS Effluent Load Rate})}{\text{Average TSS Influent Load Rate}}$$

$$\textbf{Average SSC Removal Efficiency} = \frac{(\text{Average SSC Influent Load Rate} - \text{Average SSC Effluent Load Rate})}{\text{Average SSC Influent Load Rate}}$$

The representative influent and effluent TSS and SSC samples described above must not be taken until any initial disturbance of the preloaded material in the device caused by the initiation of flow into the device has subsided and the inflow and outflow rates from the device have equalized. Following this initial time period, these representative influent and effluent TSS and SSC samples must be taken one residence time apart following the initiation of flow into the device. In addition, these representative influent and effluent TSS and SSC samples must be taken from the entire influent and effluent flow. Therefore, where bypass may occur for the flows sampled, the effluent sample must be taken downstream of the point where the waters flowing through and bypassing the device's treatment area recombine. Doing so may require the construction of an appropriate flow bypass device, particularly for those devices that do not have an internal bypass.

Annual TSS Removal Rate

The rainfall weighting factors in Table 2 are based on the total volume of annual runoff on an average year in New Jersey. The annual TSS removal rate shall be computed by multiplying the average TSS removal efficiency for each flow rate for each of the two particulate concentrations by the weighting factors in Table 2.

The removal efficiency for the MTD must be performed in the following manner:

1. For each influent concentration (i.e., 50 and 100 mgl), calculate the average removal efficiency for each tested flow rate as described in the **TSS Removal Rate** section above.
2. Multiply the average removal efficiency for each tested flow rate by the Annual Weighting Factor for that flow rate in Table 2.
3. Sum the values to achieve annual TSS rates for each concentration.
4. Average the TSS removal rates for the two particulate concentrations to obtain an annual TSS removal rate for the device.

The computation of the efficiency of a BMP cannot be based on the achievable efficiency. The achievable efficiency is defined in the "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National BMP Database Requirements," April 2002 by EPA and ASCE.

Table 2	
Tested Flow Rate as a Percentage of Maximum Treatment Flow	**Annual Weighting Factor**
25%	0.25
50%	0.30
75%	0.20
100%	0.15
125%	0.10

Scaling of Devices with Different Maximum Treatment Flow Rates

The TSS removal rate determined for the tested device may be applied to similar devices with different MTFRs provided that

1. The ratio of the Maximum Treatment Flow Rate to Effective Settling Area for the similar device is the same or less than the tested device;
2. The ratio of Maximum Treatment Flow Rate to Filter Area for the similar device is the same or less than the tested device; and
3. The relationship of the MTCR and MTFR of for the similar devices is the same as the tested device.

The MTFR for the similar device is to be determined either through the MTFR laboratory procedures as described above or by using the MTFR flow equation and applicable device dimensions, water levels, and coefficients developed for the tested device.

Maintenance During Lab Testing Process

The lab report must include documentation of any maintenance that occurs on the devices during the laboratory testing process, including frequency, reason for maintenance, and amount of sediment removed, if applicable.

D. Maintenance

Maintenance Interval

Filtration devices are typically composed of a sedimentation component and a filtration component. The required maintenance interval for the sedimentation portion of the device shall be based upon the time the device will capture 50% of the maximum sediment storage volume. The maintenance interval computations are provided in the "Requirements for Interim Certification of Hydrodynamic Sedimentation Devices for Total Suspended Solids Based on Laboratory Testing."

Filter maintenance intervals are based upon the time it takes for the material to clog the filter so that the MTFR reduced by 10% as it passes through the filter media as discussed above. Some filter cartridges can be cleaned and re-commissioned while others must be replaced to restore the MCFR.

An interim certification shall only be obtained from the NJDEP if the sedimentation portion of the device has a minimum maintenance interval of 6 months and a filter replacement/recommissioning interval of one year. The certification shall include limitations on both the allowable MTFR for the filter as well as maximum inflow drainage area based on the maintenance interval.

The maximum inflow drainage area per filter shall be estimated by the following equation:

$$\text{Maximum Inflow Drainage Area in Acres} = \frac{\text{(MTD's MTR in cfs) X (Weight of TSS in lbs per yr Before 10\% Loss in MTFR)}}{(400^{*}\ \text{lbs/acre-yr})(3.2\ \text{inch/hr})}$$

* If the loss of flow rate is based on field testing, a denominator of 200lbs/yr shall be used.

E. Submission Requirements for Device Verification and Certification

1. Pre-Laboratory Testing Submittal

a. Basis of Maximum Conveyance and Maximum Treatment Flow Rates
b. Basis of Maximum Sediment Storage Depth and Volume
c. Basis of Effective Treatment Area
d. Maximum Treatment Flow Rate Determination and Equation

2. Post-Laboratory Testing Submittal

a. Schematic drawings and photographs of lab testing setup.
b. Detailed drawings of device tested in the lab, indicating constants or variables in different sizes of the same device
c. Comparison of Requirements Vs. Actual Values for the following:
   - Flow Rates
   - Concentrations
   - Water Temperatures
   - Specific Gravity
   - Particle Size Distribution including plot of both required and actual values.
d. Comparison of times that influent and effluent samples were taken for each flow rate and influent concentration starting from the time of initiation of flow into device.
e. All raw measurements and data from lab testing.
f. All pertinent computations, including average influent and effluent concentrations, load rates, average removal efficiencies for each flow and concentration, weighted removal efficiency for each concentration, final device annual TSS removal rate, and maintenance interval.

3. Verification Report Requirements

In addition to the documentation listed above, verification reports must include the following information:

Description of Technology

Describe how the MTD works, including its physical, chemical, and/or biological treatment functions. The description must include the main treatment processes in the MTD and any ancillary processes required for the unit to function in accordance with the performance claim with respect to the pollutants of concern. The submission should also indicate what other types of BMPs, based on their treatment processes, can or cannot be used in series with the device to provide enhanced removal rates.

A comparison to the design of the standard BMP as shown in the New Jersey Stormwater Best Management Practiced Manual should be provided where applicable. (For example, a wet pond's pollutant treatment is mainly based on the residence time of the permanent pool, the volume, and the drawdown time of the water quality design storm above the permanent pool. A pool/drawdown MTD should at a minimum provide these comparisons.)

Indicate how the lab test relates to field placement. Provide a detailed discussion of the differences between the lab test and a field installation, and how the lab test mimicked or provide a more or less conservative performance than would occur in actual applications.

Installation requirements

Provide installation criteria such as soil characteristics, slope, and limitations on tailwater, and depth to seasonal high water table that are important to ensure the performance of the device.

Maintenance Plans

Maintenance plans must contain specific preventative and corrective maintenance information. All maintenance documents must be written in non-technical language. In order to ensure incorporation of appropriate maintenance, a detailed maintenance plan for each MTD must be provided that incorporates the following:

- Minimum recommended maintenance frequency for each component in order to achieve the annual TSS removal rate.
- Description of what conditions trigger the need for maintenance and how neglect of specified maintenance activities (e.g., sediment removal, filter media replacement, oil removal) causes BMP underperformance;
- Location of Access Points and type of inspection needed – whether above ground or underground;
- Training needed to Perform Maintenance. This may include training videos to be made available to maintenance staff.
- Equipment needed for maintenance and discussion of obtaining replacement parts. This must indicate what portions of the MTD are only available through the vendor.

Units

All dimensions must be consistent with standard units utilized in stormwater management design: **Length/distance**: inches, feet; **Area**: square feet, acres; **Volume**: cubic feet; **Velocity**: feet per second; and **Flowrate**: cubic feet per second.

Basis of Maximum Inflow Drainage Area Equation

To obtain the maximum inflow drainage area per filter; the following equations, units and variables shall be utilized. The Rational Method ($Q=CIA^1$) shall be employed to calculate the inflow drainage area to the MTD. The flow rate, Q, shall equal the MTD's MTFR in cfs, the runoff coefficient, C, shall equal 1.0 (maximum runoff coefficient for impervious area), and the intensity, I, shall equal 3.2 in/hr (maximum rainfall intensity for the time of concentration equal to or less than 10 minutes). The resulting area (A^1) will be in acres. This area (A^1) represents the inflow drainage area without TSS.

$$\text{MTD's MTFR in cfs} = 1.0 * 3.2 \text{ in/hr} * A^1$$

$$Q = C * I * A^1$$

$$A^1 \text{ in acres} = \frac{\text{MTD's MTR in cfs}}{3.2 \text{ inch/hr}}$$

Utilizing the TSS load for Commercial Land Cover (Table 3-1: Pollutant Loads by Land Cover in the NJBMP Manual) and a safety factor of 2, 400 lbs/acre/yr shall be multiplied by the area (A^1). A safety factor shall not be required if field data is utilized. This results in a TSS lbs/yr for the respective area and respective land cover.

$$200 \text{ lbs/acre/yr} *2 = 400 \text{ lbs/acre/yr}$$
$$400 \text{ lbs/acre/yr} * A^1 = \text{TSS lbs/yr}$$

Applying the weight of TSS reached before the reduction in MTFR divided by the resultant TSS lbs/yr for the respective area will yield a Ratio of TSS. The weight of TSS before reduction in MTFR is assumed to equal a one year replacement/re-commissioning frequency.

$$\text{Ratio} = \frac{\text{Weight of TSS (lbs/yr) Before 10\% Reduction in MTFR}}{\text{TSS (lbs/yr)}}$$

The maximum drainage area in acres, for a filter replacement interval of one year shall equal the product of the Ratio and the inflow drainage area without TSS (A^1).

$$\text{Ratio} * A^1 = \text{Maximum Drainage Area}$$

References

EPA and ASCE, "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National BMP Database Requirements," April 2002.

State of Washington Department of Technology, "Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE)," January 2008.

Wisconsin Department of Commerce, Wisconsin Department of Natural Resources, "Method for Predicting the Efficiency of Proprietary Storm Water Sedimentation Devices (1006)," May 2008.